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AUTOMIZATION OF AGRICULTURE PRODUCTS DEFECT DETECTION AND GRADING USING IMAGE PROCESSING SYSTEM

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ABSTRACT

Grading of fruit is important phase after harvesting and before marketing. The automatic fruit grading system extracts its defective region and grading, according to its level of defection. The classification of Fruit is done into four categories by considering smaller changes in defective parts, so it increases output efficiency and user acceptance level of different fruit categories.

In this proposed system of image processing algorithm, rgb2gray method and median filter are used to pre-processed the input image and convert it into gray scaled image; after that input image is segmented using modern iterative tri-class threshold based on Otsu's method for classifications in terms of defect, extract statistical features texture and shape, with the normalized Symmetric GLCM method. For testing purpose, Apple images data collected from the database provided by Mechanics and Construction Department of Gem-bloux Agricultural University of Belgium [8] have been used. Fruits are classified into four categories by using kNN method with 95% accuracy (Category 1, Category 2, Category 3 and Category 4).

KEYWORDS: Otsu's, Tri-class Thresholding, GLCM, Multi Spectral, Four Categories & KNN

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Original Article

INTRODUCTION

Image processing applications are extended by giving computer vision in various fields. In image processing, different information is extracted from image, also provide necessary theory and algorithm in the field of multimedia, medical and agriculture. Here, combination of hardware and software is used for the purpose of processing images. Now a day, computer vision technology is adopted in agriculture field to detect defects in products. In India, agriculture is most important field because; most of the people depend on farming. So, there is needed to detect defect and improve product quality, it will automatically increase market price. In food industries, before sending product to market, there is need of grading. Grading is normally performed on the basis of external defects on skin of fruits or vegetables. Traditionally, food products are inspected by manual inspection, which is more time consuming and less efficient for large industries. The computer vision techniques are more helpful, as it gives consistent result.

In the area of Image processing using advanced technology, it is possible to perform automatic grading of fruits and vegetables. This reduces the cost; improve quality, increase market price and user acceptance ratio. Some automatic grading systems are available, that uses classification techniques on the basis of color, texture, size and

shape. But capturing all these details is very challenging task.

In automatic grading system, feature extraction and classification are main and challenging task. But before that, to improve visual effects of input image, pre-processing image enhancement is done by using median filtering, which helps to remove noise and to improve edges of fruits. Also, to improve contrast and brightness effects, image is converted from rgb2gray. Image segmentation is one of the important steps; which is used to segment defective part by iterative tri-class thresholding Otsu's method, to more focus on particular defective part. Then, defect feature extraction is done by using GLCM, and classifies images by using k nearest neighbor (kNN), comparing with training images which are already stored in database [1]. Then, find out the pattern similarities and classify it in four categories Category 1, Category 2, Category 3 and Category 4 [2]. It will improve efficiency of grading system and also gives better results. This system is very helpful to food industries for Apple grading.

Lots of researchers had worked on image processing applications in agriculture field to detect fruits or leaf diseases, finding defects in fruits. The process uses size, color, texture for grading of Apple. Human inspection using visual reorganization is not always accurate and it requires more experience. The color and texture are important features for fruits and vegetables analysis. Texture is useful to detect the outer surface parameters. Classification of input image is also important task, because accuracy is varying as per classification category, and efficiency is depending on number of categories.

Shyla Raj et al [1] developed Fuzzy C means (FCM) clustering method, which is used for defect segmentation, features from defect part is extracted using Histogram of Oriented Gradients (HOG) method and Apple classification is performed by using Multi-Class Support Vector Machine (MSVM) with accuracy of 97.5% for two category grading i.e. healthy and defected and 94.66% for Multi-Category Grading i.e. Healthy Apple, Slightly defected Apple and seriously defected Apple.

Unay and Gosselin [10] proposed a comparative study about the performance of different thresholding methods such as Otsu, Isodata and Entropy and different Artificial Neural Network (ANN) methods such as Linear Discriminant Classifier (LDC), Fuzzy Nearest Neighbour Classifier(fuzzy k- NN), Nearest Neighbour Classifier (k-NN), Adaptive Boosting (Adaboost) and Support Vector Machine (SVM) with two bandwidth (RE and IR). The defect segmentation was done using thresholding method. Statistical features were extracted from defect segment and fruits were classified using supervised classifier. The classification accuracy was highest with SVM classifier with Isodata threshold method in RE band with accuracy of 89.2%.

Leemans et al. [2] proposed a method to grade ‘Jonagold’ apples, based on its external quality. Ground colour grading classification and Gaussian model of fruit colour was used for defect detection. Geometric, colour and texture features were considered to categorize the fruit. The apples were graded into four grades (Extra, category I, category II and reject) using Linear Discriminant Analysis (LDA) and accuracy of 72% was achieved. In this method, the fruit in category ‘Extra’ were graded better than those belonging to other groups, and the fruits having bruises were poorly graded.

Ismail Kavdir et al. have developed a system for grading of apple using Fuzzy logic (FL) as a decision making support. They have used color, size and the defects of apples’ quality features were measured through different equipment. By using the same set of apples, grading was done by both a human expert and a FL system, designed for this purpose. Grading results obtained from FL showed 89% general agreement with the results from the human expert, providing good

flexibility in reflecting the expert's expectations and grading standards into the results [11].

K-Nearest Neighbor's algorithm is also used to compare input data with the trained data. It uses the Euclidean distance measures to measure the distance between points in the input data and trained data. PragatiNinaws et al [14] proposed new fruits recognition techniques with combination of four features analysis method i.e. shape, size and color, texture based method to increase accuracy of recognition. For feature extraction, they calculated mean value for RGB component, and shape by threshold segmentation, and also calculate area, perimeter, roundness and entropy values. The recognition result of accuracy was up to 90%, using KNN algorithm [14]. But, the limitation of this method is, only two classes were considered for grading.

Unay and Gosselin [4] proposed a comparative study about the performance of different ANN to grade the apples. The fruit image was separated from background by threshold method. The intensity values of each pixel were used as local features, additional to local features Average, Standard Deviation and Median were selected as global features. The author compared performance of LDC, fuzzy k-NN, k- NN, SVM and AdaBoot to classify apples into healthy and defected categories. The highest accuracy of 90.3% was achieved by SVM classifier. The main limitation in this study is, only two classes were considered for grading.

Unayetal proposed the apple grading system with cascade SVM approach. The defective region is segmented by using MLP based method with pixel wise classification. The Sequential Floating Forward Selection (SFSS) method is used for feature extraction. The multi category apples classification performed with cascade SVM classification with 85.6% accuracy. The textural features are considered, but this method is computationally expensive.

Ms. KambleAnuraradha et al [21] developed system for grading of Apple fruit disease by using multi grading classification. The colour, morphological and texture features are extracted form pre-processed image. And, on the basis of percentage of affected area, Apple is classified into one of category as either Normal, Partially affected, moderately affected, unhealthy.

K. Vijayarekha [20] developed system for defect identification of apple fruit image using multivariate analysis technique for defect segmentation. The system uses visual and near infrared region taken for the study. This technique group all the pixel having same spectral property into single cluster, irrespective of spatial position of pixel, so, the external defects can be easily identified using this method. But, this required proper setup to capture and process the apple, which is quite expensive.

It is clearly seen from the literature that, some of the proposed methods have only two or three class grading, and in some of the work, the dataset size used for the experiment was very small, due to which, efficiency of the method could not be evaluated efficiently. Those authors, who have worked on multi spectral classification, could not get more accuracy.

METHOD USED

For this Apple grading work iterative segmentation, feature extraction and classification methodologies are used. Here, otsu's with iteratively searched for sub region method is used for segmentation, and for defective segmentation, the part which separates foreground and background of image part iteratively with smaller changes is used. The GLCM method is used to extract texture and shape features. kNN method is performed for classification with Euclidean distance, to match the pattern with training data, and categorised that apple into one of category either Category 1, Category 2, category 3 or Category 4.

Algorithm

Data: The data set of Apple images

Result: Grade of Apple (Category 1, Category 2, Category 3, Category 4}

Repeat

Read the image from dataset

Pre-processed that image using rgb2gray, median filter, enhancement

Apply iterative segmentation

Repeat

Iteratively Partition into object, background and to be determined region

Find the area of TBD region

Until threshold value less the preset value

Extract grayscale features

Extract texture feature using GLCM method

Extract shape feature

Until all Apple training images

Compare input image and training dataset

Classify using 16-nearest neighbor

val = rem(Sind(1)/4,1)

To enhance the image, convert input image to RGB to Gray, and then, use of median filtering remove the noise. The median filter is typical pre-processing step to remove noise by preserving original image edges. An image enhancement is used to improve the perception of information of images for human visibility, and to provide better input to image processing technique.

Image Segmentation

Iterative tri-class threshold technique is used for image segmentation. It means that, the image segmentation is based on Otsu's method, but iteratively searches for sub region of the image. This method starts with Otsu's threshold, then compute two mean values of two classes (foreground and background), separated by threshold. Based on these two things, the method separates the image into three classes instead of two classes, which standard done by Otsu's method. The first two classes are foreground and background, which will not be processed further. The third class which is denoted as to be determined (TBD) region is processed on next iteration, and repeated the same procedure, until calculated Otsu's threshold between two iterations is less than the pre-set threshold. This iterative method divide region into smaller part than previous iteration, so it processed the region in depth.

$$U = F^{[1]} \cup B^{[1]} \cup \Omega^{[1]} \quad (1)$$

Where, ∪ is logical union of operation

For second iteration, it performs Otsu's method to find threshold on region $\Omega^{[1]}$only.

$$\Omega^{[1]} = F^{[2]} \cup B^{[2]} \cup \Omega^{[2]} \quad (2)$$

Feature Extraction

Detecting defect part and extract feature is a challenging task, because there is various variety in size, shape, colour and texture of apple. So, there is need to extract global feature of image. So, GLCM method is used for feature extraction.

Texture is one of the important characteristics used in identifying regions of interest or objects in an image. GLCM is one of the statistical methods of examining texture that considers the spatial relationship of pixels is the GLCM, also known as the gray level spatial dependence matrix. The GLCM functions are used to characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship that occurs in an image. This created GLCM is then used for extracting statistical measures. GLCM is a second order statistical feature, which contains information about pixels having similar gray level values in an image.

Directional analysis [3] of P (0°), P (45°), P (90°), P (135°) in an image: If the adjacent pixel to the pixel of interest is along x axis, then it referred to as 0° directional analysis. If the adjacent pixel to the pixel of interest is along 45°, then it is referred to as 45° directional analysis. If the adjacent pixel to the pixel of interest is along 90°, then it is referred to as 90° directional analysis. If the adjacent pixel to the pixel of interest is along 135°, then it is referred to as 135° directional analysis. For each direction, GLCM can be calculated. We can obtain four different GLCM for the same image or image sub-region.

The GLCM method extracts Energy, Correlation, Homogeneity, and Contrast. The Energy measures textural uniformity and image smoothness.

Classification

Classification is also one of the challenging tasks; here classify the input image into one of the categories, by comparing with training data. The system stores the information about training dataset. kNN is simple and robust method for classification. We can use certain neighbor measure to calculate the neighbor degrees of testing and training samples on training sets, and then classify it with its label of the K nearest neighbor, if its K nearest neighbor contains a number of labels, the samples will be assigned to the majority class of their K nearest neighbor.

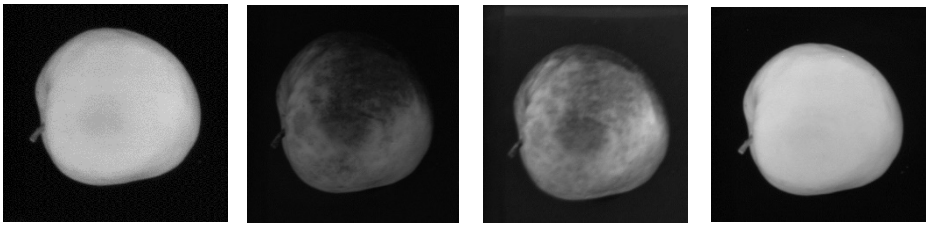
In this classifier, the testing feature vector is classified by considering k nearest neighbour vector [8]. The distance between training and testing data will be calculated by using Euclidean distance and on the basis of this, value input image will be categorized into category1, category2, category3 or category4.

$$d(p,q) = \sqrt{\sum_{i-1}^{N}(q_i - p_i)^2} \quad (3)$$

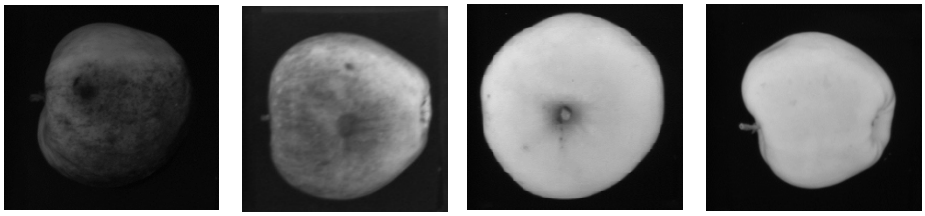
EXPERIMENTAL RESULT AND DISCUSSION

For experimental purpose, we have taken apple images from database provided by Mechanics and Construction Department of Gem-bloux Agricultural University of Belgium. Initially, median filter is used to remove noise and

enhanced input image, then Iterative Triclass thresholding Otsu's method is applied to segment the image into three classes; foreground, background and TBD. Again, TBD is divided into three classes in next iteration. Repeat same procedure for considering smallest part of defective region. Then, by using GLCM method, texture features are extracted from considering defective region. Then, by comparing extracted region with training dataset, classify that image into one of categories as Category1, Category 2, Category 3, or Category 4. The training and testing phases are used in experiment. For training, 70% images of healthy Apples and defective Apples are used. For testing, 30% images of healthy Apples and defective Apples are used. Finally, in testing phase, the given input Apple image is categorized into Cattegory1, Category2, Category 3, or Category 4.



1_1 5_2 10_3 11_1



11_2 11_3 11_4 12_1

Figure 1

Table 1

Method	Accuracy
Leemans et al (2002)	72.0%
Unay et al (2010)	85.6%
Proposed System 95%	

$$\text{Accuracy} = \frac{\text{Sum of correctly classifid Image}}{\text{Total No of Image}}$$

$$\text{A}ccuracy = \frac{57}{60}$$

$$Accuracy = 95\%$$

Below are the graphs showing the accuracy as per the calculation.

Table 2

S. no	Successful Rate	Error Rate
1	95	5

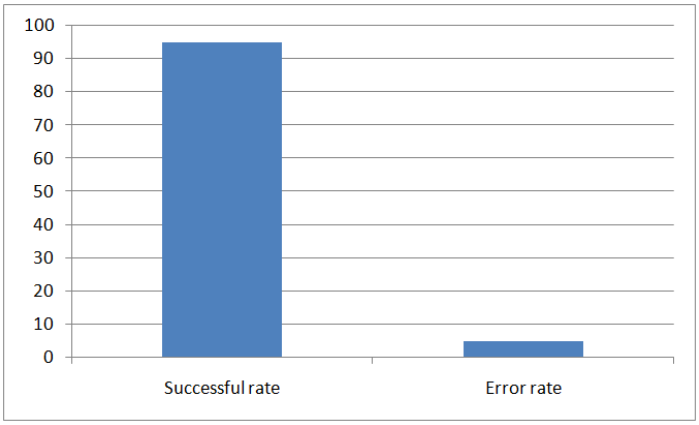


Figure 2: Graph

CONCLUSION AND FUTURE SCOPE

The automatic defect detection and grading system processed on defective part of input fruits image. The defects are segmented using iterative triclass Otsu's method into smaller part. Then from defect segment, features are extracted by using GLCM method. Finally, apple is categorized into one of category by using kNN classification (Category 1, Category 2, Category 3, or Category 4) method with 95% accuracy. Here, we have taken samples of Janagold Apples for testing purpose.

For future scope, instead of using preexisting images of fruits, we can use live cameras to capture images and then categorize them.

REFERENCES

1. *Shyla Raj; D. S. Vinod Automatic Defect Identification and Grading System for 'Jonagold' Apples, 978-1-5090-1025-7/16/$31.00 ©2016 IEEE*
2. *V. Leemans; H. Magein; M. F. Destain, On-line Fruit Grading according to their External Quality using Machine Vision, Biosystems Engineering, vol.83, no. 4, pp. 397-404, Dec 2002.*
3. *Devrim Unay, Bernard Gosselin, A quality grading approach for Jonagold apples 3rd IEEE International Symposium on Signal Processing and Information Technology, pp 271-273,2003.*
4. *Devrim Unay, Bernard Gosselin, Artificial Neural Network-based segmentation and apple grading by machine vision, IEEE International Conference on Image Processing, volII, pp 630-3, Sept 2005*
5. *O. Kleynen, V. Leemans, and M. F. Destain, Development of multispectral vision system for the detection of defects on apples, Journal of Food Engineering, Elsevier, vol 69, pp 41-49,2005*
6. *Hongmin Cai, Zhong Yang, Xinhua Cao, Member, IEEE, Weiming Xia, and Xiaoyin Xu, Member, IEEE, "A new Iterative TriclassThresholding Technique in Image Segmentation", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 23, NO. 3, MARCH 2014*
7. *Girisha A B, M. C. Chandrashekhar, Dr. M. Z. Kurian, " Texture Feature Extraction of Video Frames Using GLCM", IJETT, Volume 4 issue 6 June 2013*
8. *Vijay Wasule, Poonam Sonar, "Classification of Brain MRI Using SVM and KNN Classifier", ICSSS, 978-1-5090-4929-5©2017 IEEE*

9. *Lai J, Ming B, Li S, Wang K, Xie R and Gao J, "An Image based diagnostic expert system for corn diseases", AgriSci in China, Vol 9, pp.1221-1229, 2010.*
10. *Devrim Unay, Bernard Gosselin, Thresholding-based segmentation and apple grading by machine vision, 13th European Conference on Signal Processing, pp 1-4, Sept 2005.*
11. *Ismail Kavdir, Daniel E. Guyer "Apple Grading Using Fuzzy Logic" Turk J Agric For 27 (2003) 375-382 © T. BÜTAK.*
12. *Monika Jhuria, Ashwani Kumar, Rushikesh Borse,"image processing for Smart Farming :Detection of disease and Fruit Grading "proceeding of the 2023 IEEE second international conference on image processing (ICIIP-2013)*
13. *Devrim Unay, Bernard Gosselin "Artificial Neural Network-Based Segmentation And Apple Grading By Machine Vision"*
14. *Pragati Ninawe1, Mrs. Shikha Pandey A Completion on Fruit Recognition System Using K-Nearest Neighbors Algorithm International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 3 Issue 7, July 2014*
15. *Yudong Zhang and Lenan Wu, "Classification of Fruits Using Computer Vision and a Multiclass Support Vector Machine", Sensors 2012, Vol: 12, p. p. 12489-12505*
16. *James C. Bezdek, Pattern Recognition with Fuzzy Objective Function Algorithms, 1981*
17. *Kumar, S., Singh, R., Rao, D. U. M., Kumar Gupta, S., & Sharma, S. (2017). Knowledge Management in Agriculture: A Critical Analysis.*
18. *Devrim Unay, Bernard Gosselin, Olivier Kleynen, Vincent Leemans, Marie- France Destain, Olivier Debeir Automatic grading of Bi-colored apples by multispectral machine vision, Computers & Electronics in Agriculture, Elsevier, vol 75, no1, Pages 204212, Jan 2011*
19. *R. Sriram, J. M. Francos and W. A. Pearlman, "Texture coding using a word decomposition based model", IEEE Transactions of Image Processing, vol. 5 (1996), pp. 1382–1386.*
20. *M. R. Vishnu Priya, M. Sankara Gomathi, " An Effective Image Segmentation Using Triclass Otsu Thresholding and Loyld's Clustering Method", International Journal of Advanced Technology in Modern Engineering, vol 2, ISSN No. 3290-1627, April 2015.*
21. *K. Vijayrekhaa, "Multivariate image analysis for defect identification of apple fruit images" IEEE 2008. Computer science technology.*
22. *Miss Kamble, AnuradhaManik, Dr. Chaugule, "Grading of Apple Fruit Disease" International journal of engineering sciences and research technology.*